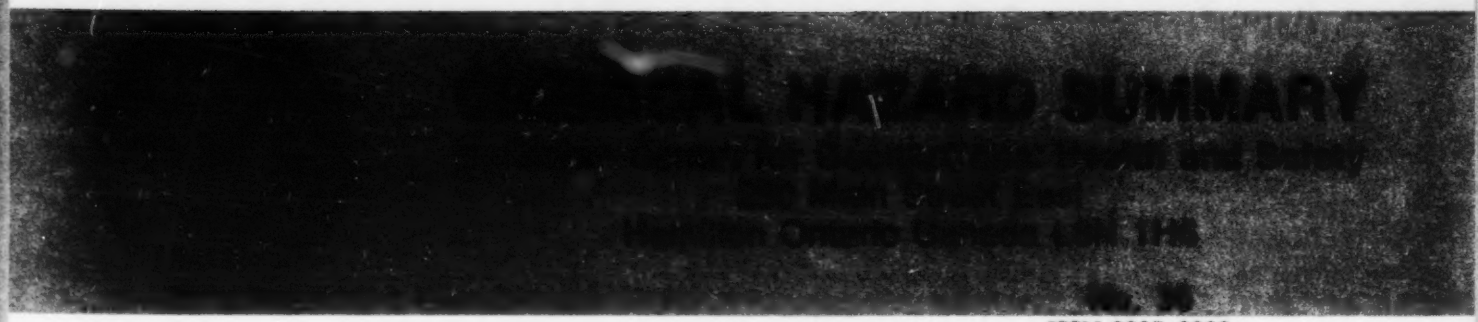

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CARBON DISULFIDE

(CAS 75-15-0)

SCOPE OF THE DOCUMENT

This document focuses on the hazards of carbon disulfide. The toxicity, fire, explosion and reactivity hazards of carbon disulfide are described. Information relevant to the workplace is emphasized. Special attention is given to the main hazard presented by carbon disulfide.

CARBON DISULFIDE - CHEMICAL HAZARD SUMMARY NO. 36

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I. MAIN HAZARD

The main hazards of carbon disulfide are its toxicity to the nervous system, to the heart and circulatory system and its extreme flammability.

II. OCCUPATIONAL EXPOSURE

Carbon disulfide is a clear or slightly yellowish liquid. When pure, it has a slightly sweetish odour. Old or impure carbon disulfide has a characteristic strong, disagreeable odour resembling rotting vegetation.

The principal use of carbon disulfide is in the manufacture of viscose rayon. It is also used to produce carbon tetrachloride for the manufacture of fluorocarbon chemicals; in the production of cellophane films; as a starting material for the production of agricultural, mining, pharmaceutical and rubber chemicals; and as a solvent for waxes, plastics, sulfur, selenium, bromine and iodine.[1,2]

Exposure to carbon disulfide occurs by breathing in vapour and by absorption of liquid through unbroken skin. Ingestion is unlikely in the workplace.

General information on routes of exposure is available in the CCOHS document "How Workplace Chemicals Enter the Body."[3]

III. HEALTH HAZARDS

Removal from the Body

A large portion of inhaled carbon disulfide is absorbed into the body. However, it is eliminated rapidly. About 30% of absorbed carbon disulfide is exhaled from the lungs. The remainder is converted by the body into various breakdown products and is eliminated in urine.[4,5]

Effects of Short-Term Exposure in Humans

Inhalation

Exposure to approximately 200 parts per million (ppm) causes few or only slight effects. Exposure to approximately 350 ppm for several hours may cause headache, giddiness, respiratory and gastrointestinal disturbances and narcosis.

Exposure to between 500 to 1000 ppm of carbon disulfide may cause psychiatric disturbances including excitability, confusion, irritability, uncontrollable anger, bizarre dreams, insomnia and suicidal tendencies. Exposure at 4800 ppm for 30 minutes results in coma and, sometimes, death.[2,4]

Eyes

Splashes in eyes cause severe, immediate irritation. High airborne vapour concentrations also may cause irritation of the eyes.[6]

Skin

Carbon disulfide is absorbed through unbroken skin.[6] Unbroken skin means that there are no cuts, scratches, or inflammation of the skin. Ingested quantities have effects similar to those described for inhalation.[4] Splashes on skin cause blistering and skin sensitization. Damage may result to nerves near the site of absorption.[4]

Ingestion

Ingestion of small quantities of carbon disulfide may result in vomiting, diarrhea and headache. Larger quantitites may result in convulsions and coma. Death has been reported after swallowing about 18 grams of carbon disulfide.[7]

Effects of Long-Term Exposure in Humans

Effects on Body Tissues and Organs

The effects of long-term exposure to carbon disulfide have been extensively reported since the late nineteenth century. The first reports of health effects involved rubber workers. Since the 1940's the reports have involved viscose rayon workers.[2]

Central Nervous System

The central nervous system includes the brain and spinal cord.

Long-term exposure to carbon disulfide causes a range of effects on the central nervous system. Initial effects are shown by unrest, excitation and quick loss of temper. Common symptoms include nightmares, apathy and headaches. There is a gradual development of depression, anxiety, paranoia and, sometimes, suicidal tendencies.[4] Continued exposure may result in speech disturbance, memory loss, tremour, lack of muscle coordination and psychotic effects. The symptoms appear similar to those encountered in Parkinson's disease.

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Peripheral Nervous System

The peripheral nervous system includes nerves which sense (for example, taste, temperature and light), and nerves which control movement.

Long-term effects to the peripheral nervous system are shown by numbness or tingling, muscle weakness, muscle pain and loss of sensation in the toes, feet, fingers and hands. Changes to and destruction of nerves to the face, eyes, and ears may result from long-term exposure to carbon disulfide.[8]

The Heart and Circulatory System

Long-term exposure to carbon disulfide results in changes to the blood vessels. Blood vessels of the heart and kidney are most often affected.[9] Changes in arteries resemble the thickening and hardening which occurs from aging. Long-term exposure to carbon disulfide promotes coronary heart disease. Health studies of viscose rayon workers in Britain[10] and Finland[11] have shown a significant increase in death rates from cardiovascular disease.

Gastrointestinal System

Gastrointestinal disorders such as chronic gastritis and impaired function of the liver and bile duct have been observed in workers chronically exposed to carbon disulfide.[4]

Eye

Eye disorders due to chronic exposure to carbon disulfide have been reported including functional changes such as abnormal eyelid movement, sensitivity of the cornea, colour vision, dark adaptation and reaction to light.[4] Microscopic enlargements of blood vessels (or microaneurysms) of the retina have been reported in viscose rayon workers.

Reproductive Effects

Reports suggest decreased sperm production and changes in sperm in young workers. Irregularities of menstrual cycle, increased flow and pain and increased numbers of miscarriages have been reported among women exposed to carbon disulfide concentrations of 10 ppm and less.[4,12,13] However, the studies do not provide conclusive evidence that low levels of carbon disulfide cause reproductive effects in human females.

Carcinogenic Effects

There are no reports of carbon disulfide causing cancer in man.

No data on mutagenicity in man are available.[5,6]

Toxicity Data in Animals and Laboratory Tests

The acute (or short-term) poisoning potential of a chemical in humans can be estimated by performing toxicity tests on laboratory test animals. Sometimes, when the toxicity of a chemical is well known in humans, animal testing would not provide additional useful information. For carbon disulfide, this appears to have been the case. Consequently, there is only very limited animal acute toxicity data for carbon disulfide.

There are no reports of studies indicating cancer-causing or mutation-causing effects of carbon disulfide in animals. Reports of studies on the teratogenic effects (causing birth defects) in animals suffer from poor experimental design and analysis of results.

IV. FIRE AND EXPLOSION HAZARDS

Carbon disulfide is an extremely flammable liquid. It has a low flash point and very wide flammable or explosive limits. Carbon disulfide has a high vapour pressure which allows high vapour concentrations to accumulate at normal room temperature and pressure.

The hazard of fire or explosion is normally described by the flash point and flammable or explosive limits of the substance.

The flash point of carbon disulfide is -30C (-22F). When the material is at or above this temperature, enough vapour is produced just above its liquid surface to form a flammable or explosive mixture of vapour and air. Any ignition source may cause this mixture to burn or explode.

The flammable or explosive range is 1.3-50% (13,000-500,000 ppm) of the material in air. The lowest concentration of the material in air which can burn or explode is called the Lower Explosive Limit (LEL) or the Lower Flammable Limit (LFL). The LEL is about 1.3% for carbon disulfide. When the concentration is below the LEL, the air-chemical mixture is too "lean" to burn. Similarly, the highest concentration of the material in air which can burn or explode is called the Upper Explosive Limit (UEL) or the Upper Flammable Limit (UFL). The UEL is 50% for carbon disulfide. When the concentration is over the UEL, the mixture is too "rich" to burn. Between the LEL and the UEL, possible hazards include explosion and flashback. Flashback is a fire travelling back from a spark or flame along the line of vapour or gas to a container or spill. Adequate general or local exhaust ventilation can prevent the accumulation of explosive concentrations of the airborne material in work or storage areas. The airborne concentrations within the flammable or explosive range are significantly greater than the concentrations represented by the Threshold Limit Value and represent a significant exposure hazard in addition to being a fire or explosion hazard.

The auto-ignition temperature is the lowest concentration at which a material begins to burn in air in the absence of a spark or flame. Auto-ignition is a result of the chemical decomposition of the material. Auto-ignition temperatures can vary by 100C or more depending on the test method used, so listed values should be considered approximate. Materials must be stored and handled at temperatures well below their auto-ignition temperature. A low auto-ignition temperature can indicate that a material is dangerously unstable or susceptible to spontaneous combustion.

The auto-ignition temperature for carbon disulfide is 90C (190F). For example, the temperature of bare steam pipes could be sufficient to ignite carbon disulfide.

V. CHEMICAL REACTIVITY

Carbon disulfide may react violently with chemically reactive metals and their compounds (such as aluminum, potassium or zinc). It may form explosive salts with metal oxides (such as rust or iron oxide). Carbon disulfide may form explosive azido thioformates with metal azides (such as lithium azide). It may react violently with amines, bases, imines, chlorine, bromine, fluorine, nitrogen oxides and mixtures of permanganates and sulfuric acids.[14]

VI. EXPOSURE LIMITS

Many Canadian jurisdictions have exposure limits similar to those established by the American Conference of Governmental Industrial Hygienists (ACGIH). The Threshold Limit Value (TLV) established by ACGIH for carbon disulfide is a time-weighted average value of 10 parts per million (ppm) or 30 milligrams per cubic metre (mg/m^3).[15]

The ACGIH has also assigned a "skin" notation which indicates that absorption by the unbroken skin, eyes or mucous membranes may contribute to the overall exposure. This applies to direct contact with the substance or to contact with the airborne material. Other substances in which the material is dissolved or with which it is mixed can alter skin absorption.

Contact the appropriate authority in your jurisdiction for details of the specific regulations which apply. Refer to ACGIH documentation for information on the TLVs.

VII. EXPOSURE CONTROLS

Exposure to carbon disulfide is best prevented by design of the work process and engineering controls. The available types of control measures include:

- Substitution
- Isolation
- Enclosure
- Local exhaust ventilation
- Personal protective equipment
- General area ventilation
- Work practices
- Worker rotation
- Personal hygiene

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One or more of these measures may be appropriate in any particular situation. A survey of the workplace and consideration of the technical requirements of the work process are usually needed before major changes are made. Regular training should be conducted to ensure that all employees, supervisors and managers have current knowledge of job hazards and procedures, including emergency procedures.

The potential high hazards associated with carbon disulfide require that stringent control measures be taken such as enclosure, isolation or substitution.

General and local exhaust ventilation is required to control carbon disulfide. The ventilation system should be non-sparking, grounded and isolated from other exhaust ventilation systems. The material should be exhausted directly to the outside. Down-draft or lateral exhaust ventilation should be provided where vapour may escape. Canopy hoods are ineffective for capturing carbon disulfide vapour. To ensure correct operation, supply sufficient replacement air to make up for air removed by exhaust ventilation systems. Refer to the ACGIH "Ventilation manual for ventilation system design guidance."[16]

Architectural and engineering designs should avoid low points such as pits, basements or trenches to prevent accumulation of vapours.

Where feasible substitution of carbon disulfide with a less hazardous material is the preferred method of controlling worker exposure. In selecting a substitute, consideration should be given to the toxic, physical and chemical properties of the proposed substitute to ensure that no new hazards are being introduced by the change.

Protective Clothing

Wear protective clothing such as gloves, coveralls, boots and other items as needed to prevent skin contact with carbon disulfide. Clothing made of viton and polyvinyl alcohol (PVA) provide very good protection from carbon disulfide. Clothing made from butyl rubber, neoprene, nitrile and polyurethane provide less protection than the ones mentioned earlier. The resistance of specific materials may vary from product to product. The resistance of a material to carbon disulfide should be tested under the expected conditions of use.

In some cases a full body encapsulating unit and respiratory protection may be required.

Contaminated clothing should be removed promptly and stored in closed containers. It should be discarded or laundered before reuse. The laundry personnel should be informed of the presence and hazards of carbon disulfide.

Chemical safety goggles should be used to protect the eyes. A face shield may also be necessary. Contact lenses should not be worn when working with carbon disulfide.

Respiratory Protection

Factors to be considered when implementing a respiratory protection program include:

Selection of appropriate respirators
Respirator fit
Respirator maintenance
Worker training

These factors are described in more detail in CSA Standard Z94.4 "Selection, Care, and Use of Respirators", available from the Canadian Standards Association, Rexdale, Ontario, M9W 1R3.

NIOSH[17] recommends the following respiratory protection for carbon disulfide concentrations of:

Up to 10 ppm: Any chemical cartridge respirator with organic vapour cartridges; any supplied-air respirator; any self-contained breathing apparatus.

Up to 25 ppm: Any supplied air respirator operated in a continuous flow mode; any powered air-purifying respirator with organic vapour cartridge(s).

Up to 50 ppm: Any chemical cartridge respirator with a full facepiece and organic vapour cartridge(s); any powered air-purifying respirator with a tight-fitting facepiece and organic vapour cartridges; any air-purifying full facepiece respirator (gas-mask) with a chin-style or front- or back-mounted organic vapour canister; any self-contained breathing apparatus with a full facepiece; any supplied-air respirator with a full facepiece.

Up to 500 ppm: Any supplied-air respirator with a full facepiece and operated in a pressure demand or other positive pressure mode.

Emergency or planned entry into unknown concentration or IDLH* conditions: Self-contained breathing apparatus with full facepiece and operated in a positive pressure demand or other positive pressure mode; any supplied-air respirator with a full facepiece and operated in a pressure demand or other positive-pressure mode in combination with an auxiliary SCBA operated in pressure demand or other positive-pressure mode.

Escape: Any air purifying full facepiece respirator (gas mask) with a chin-style or front- or back-mounted organic vapour canister; any appropriate escape-type self-contained breathing apparatus.

*Note: For the purposes of respiratory protection the Immediately Dangerous to Life or Health concentration (IDLH) is defined as the maximum concentration from which one could escape within 30 minutes without suffering any escape impairing symptoms or irreversible health effects.

These recommendations are based on the NIOSH recommended exposure level of 1 ppm. These recommendations apply only to NIOSH and MSHA approved respirators.

VIII. STORAGE AND HANDLING

Carbon disulfide should be stored in tightly-closed, labelled containers. The containers should be stored in isolated and detached buildings away from other materials and sources of ignition. The containers should be stored in a cool area and away from direct sunlight. Small quantities should be stored, handled and dispensed in safety containers. Glass containers should be protected from breakage.

Storage areas should have floors that do not allow spilled liquids to penetrate. Storage areas should also be diked to contain spills. Consider installing leak detection and alarm equipment. Only allow authorized trained persons access to the storage area. Separate chemical storage areas from populated work areas. Post appropriate warning signs. Inspect storage areas regularly for any defects such as leaking containers. Open floor drains and low areas must be avoided to prevent accumulation of vapours.

Ground drums and bond transfer containers. Grounding clips must contact bare metal. Keep away from sparks, flames, high temperature processes and ignition sources. Post "NO SMOKING" signs in area of use. Transfer contents of drums or tanks by gravity or liquid displacement as recommended by the manufacturer.

IX. FIRST AID

The following general procedures are suggested for first aid involving occupational poisoning by carbon disulfide.

Inhalation

Take proper precautions to ensure your own safety: for example, use appropriate protective equipment. Remove source of contamination or move victim to fresh air. Remove any contaminated clothing to prevent further inhalation of vapours. If breathing has stopped, trained personnel should begin artificial respiration or, if the heart has stopped, cardiopulmonary resuscitation (CPR) immediately. Oxygen may be beneficial if administered by a trained person, preferably on a physician's advice. Obtain medical attention immediately.

Skin

Avoid direct contact with carbon disulfide. Wear impervious protective gloves if necessary. Remove contaminated clothing, shoes and leather goods such as belts and watchbands. Wash gently and thoroughly with water and non-abrasive soap. If irritation persists, get medical attention.

Eyes

Immediately flush the contaminated eye(s) with lukewarm, gently flowing water for 20 minutes, by the clock, holding the eyelid(s) open. Take care not to spill the contaminated water into the non-affected eye. If irritation persists, obtain medical attention immediately.

Ingestion

Never give anything by mouth if victim is rapidly losing consciousness, or is unconscious or convulsing. DO NOT INDUCE VOMITING. Have victim drink 240 to 300 mL (8 to 10 oz.) of water. If vomiting occurs naturally, have victim lean forward to reduce risk of aspiration. Repeat administration of water. If breathing has stopped, trained personnel should begin artificial respiration or, if the heart has stopped, cardiopulmonary resuscitation (CPR) immediately. Obtain medical attention immediately.

General

Provide general supportive measures (comfort, warmth, rest). Consult a physician and/or the nearest Poison Control Centre for all exposures except minor instances of inhalation or skin contact. Some recommendations in the above sections may be considered medical acts in some jurisdictions. All first aid procedures should be periodically reviewed by a physician familiar with carbon disulfide and its conditions of use in the workplace.

X. FIREFIGHTING

Dry chemical, carbon dioxide and inert gas are appropriate extinguishing media. Water spray can be effective in case of fires in metal containers to prevent reignition by hot surfaces. Foam is ineffective for fighting carbon disulfide fires.

Avoid contact and stay upwind. Wear breathing apparatus and suitable protective clothing. Avoid low areas; vapour is heavier than air. Vapours may travel a considerable distance to ignition sources and flash back to containers. Hot containers can rupture violently.

Carbon monoxide and sulfur dioxide are the principal decomposition products from a fire.

XI. CLEAN-UP AND DISPOSAL

Because of the toxic, fire and explosion properties of carbon disulfide, spills can be hazardous and must be dealt with promptly.

Restrict access to the spill area until clean up is completed by trained personnel. Wear adequate protective equipment. Extinguish and remove all ignition sources. Ventilate area. Notify government occupational and environmental agencies.

Do not touch spilled material. Stop or reduce leaks if safe to do so. Prevent carbon disulfide from entering sewers, low spots or confined spaces.

Small spills can be soaked up with absorbent material which does not react with carbon disulfide. Absorbent material should be placed into suitable, covered and labelled containers. Flush area with water.

Large spills should be contained with an earth, sand or absorbent material dike. Liquid should be removed by spark and explosion-proof pumps or vacuum equipment. The recovered material must be placed into suitable, covered, labelled containers. Any remaining material can be soaked up with absorbent material. The absorbent material must also be placed into suitable, covered and labelled containers. The area should then be flushed with water.

All equipment and contact surfaces must be grounded to prevent ignition by static electricity.

Review federal, provincial and local government requirements concerning disposal of waste material containing carbon disulfide.

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Note: Additional references on this subject are available from CCOHS upon request.

PLEASE NOTE

This summary was prepared at the Canadian Centre for Occupational Health and Safety (CCOHS) and is intended primarily as a source of information for persons who work with or may be occupationally exposed to this material. The information selected for inclusion is believed to be reliable and generally relevant to occupational health. Other information may be available which bears on particular work situations. The scientific data in many areas are limited and may allow a variety of interpretations. Additional information, corrections, comments and questions are welcome, and should be addressed to the Inquiries Service, CCOHS, 250 Main Street East, Hamilton, Ontario, L8N 1H6, (416) 572-2981; toll free 1-800-263-8276.

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